Indian Rats and Mice given by Mr. Oldfield Thomas, P. Z. S. 1881, p. 525 :—

	♂. inches.	♀. inches.
Head and body	3·4	3·5
Tail from anus	2·9	3
Hind foot	0·72	0·7
Fore arm and hand.....	0·88	0·87
Ear-conch, length (outside)	0·58	0·63
Muzzle to auditory meatus.....	—	1

Both skulls are much broken; that of the male has been extracted, and measures an inch in length from the occiput to the anterior termination of the premaxillaries, 0·15 across the frontals where narrowest between the orbits; the length of the row of upper molars is 0·2, of the lower molars 0·17. The skull closely approaches in form to that of *Mus mettada*, except that it is more convex above. The dentition of the two species appears to me quite similar except in size.

Mus gleadowi is indeed in many respects a miniature of *Mus mettada*. It has the same form of hind foot, with the hinder foot-pads wanting, though the deficiency appears carried further in the new species, judging by the specimens sent, in which only four pads are present, than it usually is in *M. mettada*, in which five is the usual number, though but four are often found. The small number of pads on the hind feet distinguish these two forms from all other Indian species of *Mus*, which have six, all well developed.

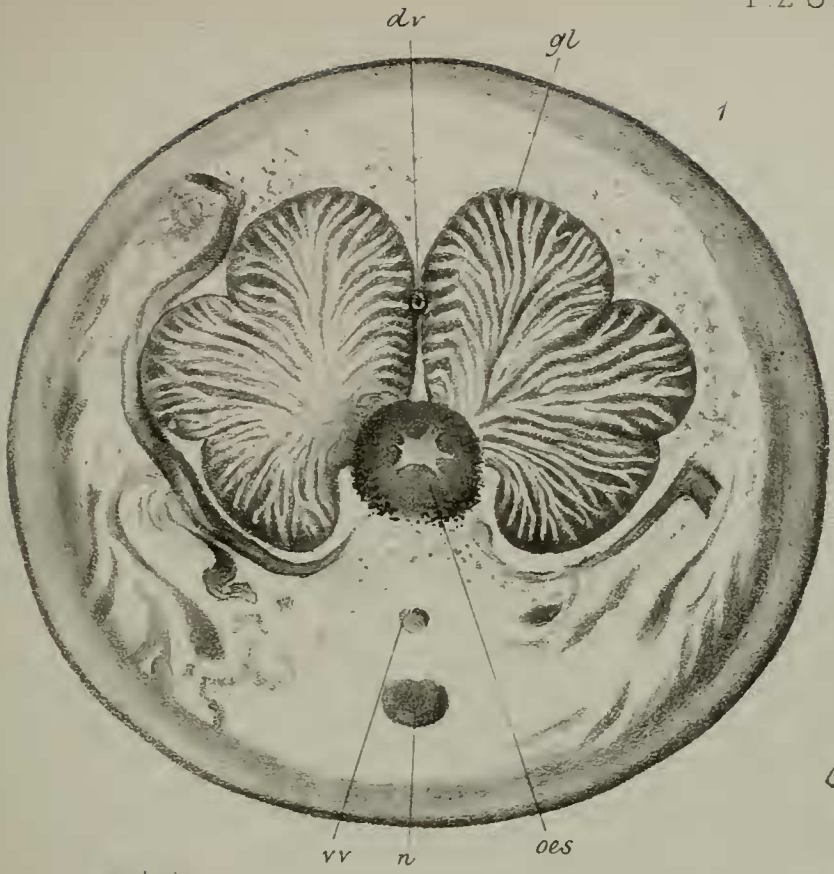
From *M. mettada* the present species is distinguished by its much smaller size, and especially by its very small feet and tarsi—the latter being much longer in proportion to their diameter than in *M. mettada*—by the colour being very much lighter, sandy brown with a slight greyish tinge above, and pure white below, and by having only six mammæ instead of eight. The eyes, too, appear proportionally much larger in *M. gleadowi*.

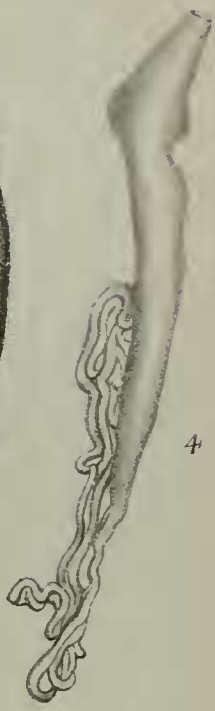
6. On the Specific Characters and Structure of certain New-Zealand Earthworms. By Frank E. Beddard, M.A., F.R.S.E., F.Z.S., Prosector to the Society.

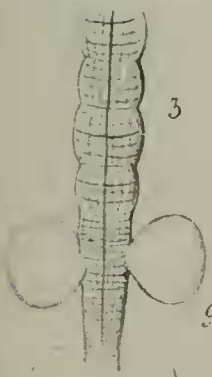
[Received October 1, 1885.]

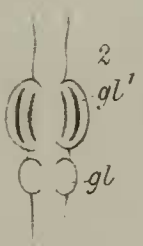
(Plates LII. & LIII.)

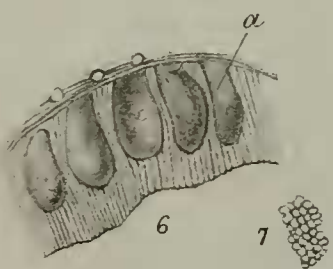
I have lately received through the kindness of Prof. T. J. Parker, of Otago University, Dunedin, New Zealand, a number of excellently preserved Earthworms collected in the neighbourhood of that town. The specimens proved to belong to three distinct species, all apparently referable to Perrier's genus *Acanthodrilus*. I have been able to study

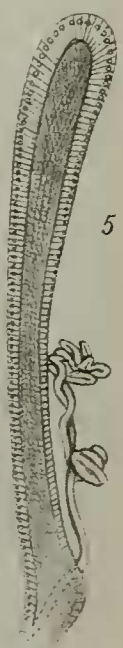


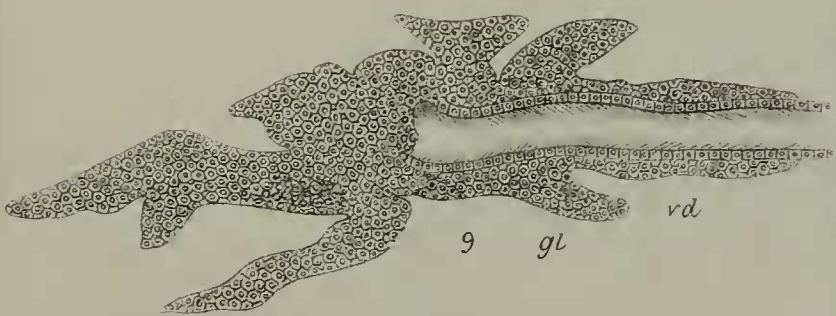






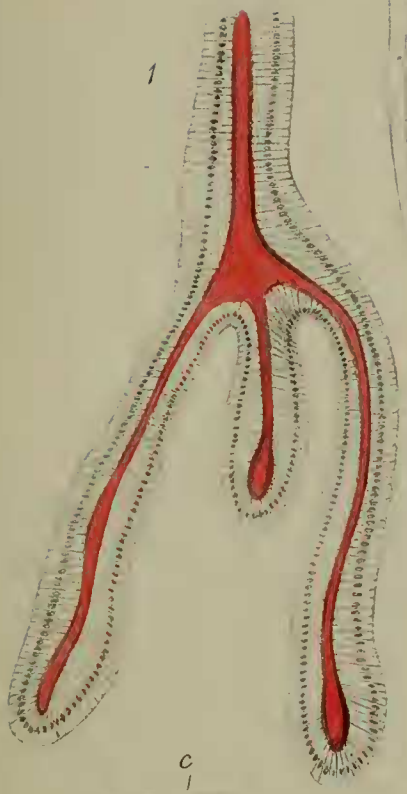


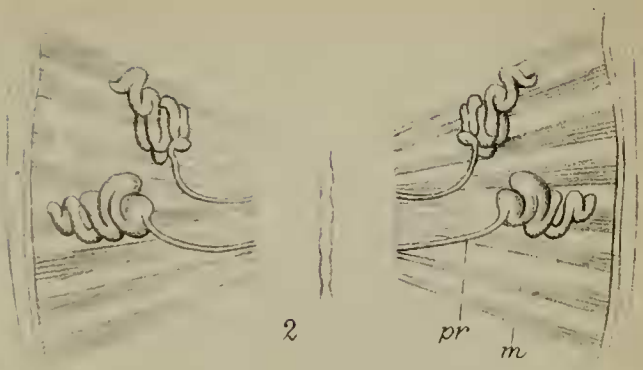


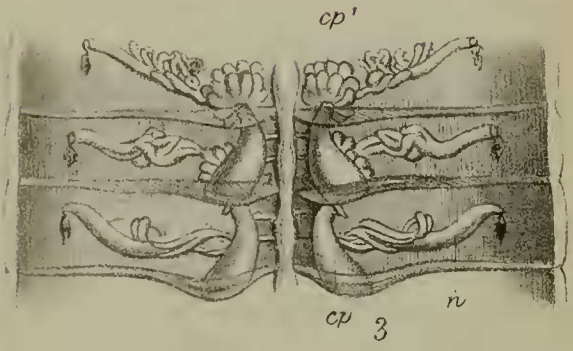


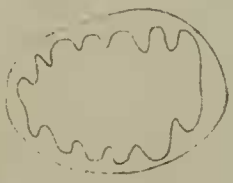
F.E.B & A.S. Barnes delt. Hanhart imp.

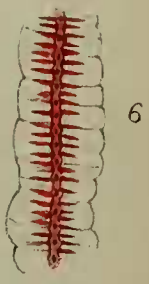
STRUCTURE OF ACANTHODRILUS

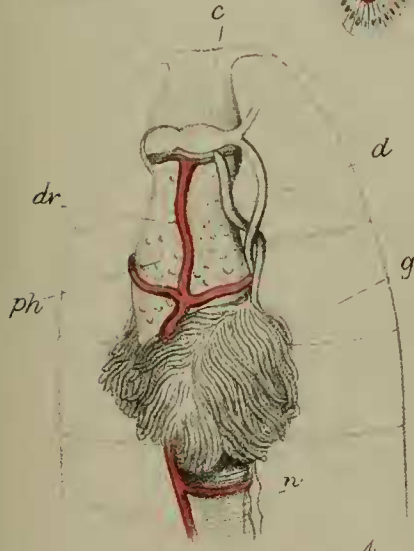


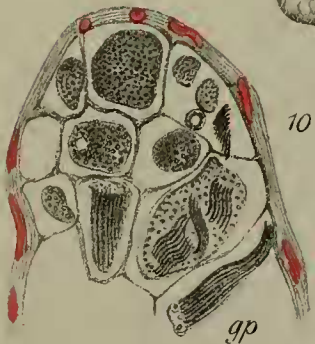












F.E.B. del.

Hanhart imp.

STRUCTURE OF ACANTHODRILUS.

these specimens in some detail, and venture to offer to the Society an account of their structure which will, I hope, help to fill up a gap in our knowledge of the anatomy of Earthworms; at present, beyond a few short descriptions of some six species of this genus, the anatomy of *Acanthodrilus* is entirely unknown. I have endeavoured in the present communication to treat of the structure of this genus in as thorough a fashion as possible, and have taken as my models the excellent memoirs of M. Perrier on *Urochæta*[1] and *Pontodrilus*[2]. The anatomy of all three species will be dealt with together, and will form the second part of this paper; the first part contains some remarks upon the genus and a brief description of three new species.

Part I.

The genus *Acanthodrilus* was instituted by M. Perrier in his 'Recherches pour servir à l'histoire des Lombriciens terrestres.'[3] It belongs to his group "Postclitelliens," inasmuch as the male generative openings are situated *behind* the clitellum. The structural characters which serve to distinguish this genus from others are:—The presence of four male generative openings, each of which is furnished with a bundle of long, peculiarly modified penial setæ, enclosed in a special muscular sac, the ends projecting through the apertures: there is furthermore a prostate gland in connection with each of these apertures; the vasa deferentia remain distinct from each other, and pass down the body from their anterior funnel-shaped internal apertures to their external apertures as four distinct tubes. The setæ are disposed in pairs as in *Lumbricus*.

M. Perrier described three species—*A. obtusus* and *A. ungulatus* from New Caledonia, and *A. verticillatus* from Madagascar. A fourth species of this genus was collected in Kerguelen during the Transit-of-Venus Expedition, and described by Prof. Lankester[4] under the name of *A. keryuelenensis*. More recently Dr. Horst has recorded the structural characters of two large species from Liberia, which he has named respectively *A. büttikoferi* and *A. schlegelii*[5]. Finally, I have myself described a seventh species from the Cape of Good Hope, under the name of *A. capensis*[6]. I shall take the opportunity presently of making some remarks upon the structural characters of these in connection with the new species to be recorded in the present paper.

Little or nothing is known about the New-Zealand Earthworms; and, so far as I am aware, there is no anatomical description of any one of the species, some seven in number, which have been recorded by Baird and Hutton[7] from this locality.

Captain Hutton, C.M.Z.S., has briefly described four species of

[1] Arch. d. Zool. Exp. t. iii.
[2] Arch. d. Zool. Exp. t. ix.
[4] Phil. Trans. extra vol. 1879.
[3] Nouv. Arch. d. Muséum, t. viii.
[5] Notes from Leyden Museum, vol. vi.
[6] Proc. Roy. Phys. Soc. 1884–85, p. 369.
[7] Proc. Linn. Soc. vol. xi. p. 96.

Lumbricus and three species of *Megascolex* in a paper published in the 'Transactions of the New-Zealand Institute'[1]; but as that author has merely referred to external characters, it is impossible to speak with certainty as to the identity or non-identity of the species which I propose to describe in the present paper with any of his. The practical impossibility of distinguishing species of Earthworms from each other by external characters only is so well known to those who have occupied themselves with the anatomy of the group, that I need scarcely insist upon it here. When, however, the relations of external characters to internal structure are known, something may be said about the systematic position of an Earthworm from its external characters, though, speaking generally, it would be unsafe to assign it to any particular genus without dissection. As far as we know at present, the genus *Acanthodrilus* can be so distinguished; the four male generative apertures on or in the neighbourhood of the sixteenth and eighteenth segments, each with the penial setæ protruding, are distinctive of *Acanthodrilus*.

After reading carefully Hutton's description of his four species of New-Zealand *Lumbrici*, I am inclined to think that three at least do not fall within the genus *Lumbricus* as at present defined and understood; these are *L. uliginosus*, *L. campestris*, and *L. levis*. In all the clitellum occupies from five to six segments situated in the anterior region of the body between segments 10 and 25; the "male genital apertures" are stated to be on the 9th segment (*L. campestris*), the 9th and 10th (*L. uliginosus*), or upon the 10th to the 15th (*L. levis*). The "vulvæ" are upon the last two segments of the clitellum. It is possible that *L. levis* is the type of an altogether new genus, but the other two species appear to me to belong to the genus *Acanthodrilus*. What Captain Hutton, following Hoffmeister, terms "vulvæ" are, I should imagine, the male genital apertures, while his "male genital apertures" may be the orifices of the spermathecæ. If my suppositions are right as to the meaning of the terms used in Hutton's descriptions, there is every probability that *L. campestris* and *L. uliginosus* are representatives of the genus *Acanthodrilus*, more particularly since this genus undoubtedly does occur in New Zealand, as will appear from my own descriptions. On the other hand, the fourth species of *Lumbricus* (*L. annulatus*) described by Captain Hutton does really seem to belong to the genus *Lumbricus*, as far as one can judge from its very incomplete definition. To the three species described in the present paper I give new names, because they appear, so far as I can make out, to differ specifically from those described by Captain Hutton; they may prove, however, to be identical; a comparison of types can alone settle the question.

The three species which I am now about to describe clearly differ from each other sufficiently to warrant their separation as distinct species. I have regarded them all as belonging to Perrier's genus *Acanthodrilus*, because they possess four male generative apertures each furnished with a prostate gland. The only other genus known

[1] Vol. xi. p. 317; see also vol. ix. p. 350.

in which there are four male generative apertures is *Moniligaster*, but in this genus the position of the orifices is different, and the anatomy of the worm is in other respects quite different from that of *Acanthodrilus*.

Acanthodrilus novæ zelandiæ, n. sp.

Setæ disposed as in *Lumbricus* in four series of pairs. Clitellum occupies 8 segments (12–19 inclusive); it is saddle-shaped, having a ventral area upon which there is no glandular development; on segments 16 and 18, corresponding to ventral row of setæ, are male genital apertures through which penial setæ protrude. The apertures of the copulatory pouches are between the 6th and 7th and between the 7th and 8th segments. The apertures of the oviducts are paired, and upon the 14th segment.

The apertures of the nephridia alternate in position from segment to segment, sometimes they are in front of the dorsal, sometimes of the ventral pair of setæ. The nephridia are furnished with a long muscular duct and a minute diverticulum, or have a large diverticulum and no muscular duct; the former are the dorsal series, the latter the ventral. The dorsal vessel is formed of two trunks anteriorly, which unite where they perforate the intersegmental septa. The intestine is unprovided with cæca or glands of any description. The testes are two pairs of racemose glands in segments 11 and 12; the vasa-deferentia funnels open in segments 10 and 11; the external apertures of the vasa deferentia are accompanied by a bundle of penial setæ and long coiled tubular prostatic gland; the ovaries are in segment 13; the oviducts perforate the mesentery, dividing this from segment 14. There are two pairs of spermathecæ in segments 7 and 8; each is a round sac with a short duct, round which are clustered a group of accessory diverticula.

Acanthodrilus dissimilis, n. sp.

This species is very closely allied to the last, and only differs, so far as I have been able to make out, in two points. The dorsal vessel is a single tube, and the copulatory pouches are furnished with only a single pair of large diverticula, one on either side.

Acanthodrilus multiporus, n. sp.

This species differs considerably from the two last. Like *A. novæ zelandiæ*, it attains to a length of from 10 to 12 inches and $\frac{1}{2}$ an inch in diameter. The setæ are disposed in eight equidistant rows of a single seta each. The clitellum occupies the same segments as in the last species, and the male genital apertures have the same position and correspond to the outermost of the two ventral setæ; there are no special penial setæ. The apertures of the spermathecæ are between 7 and 8 and between 8 and 9; they correspond in position to the outermost of the two ventral setæ.

The spermathecæ appear to be simple spherical pouches without any diverticula. The nephridia are small and delicate; each segment is furnished with 8 nephridial pores corresponding to the 8 setæ;

in the anterior part of the body there are a larger number of pores, forming a continuous ring round the body and between the setæ.

The dorsal blood-vessel is formed of two tubes which remain distinct throughout the body. The pharynx is provided with a large gland consisting of metamorphosed nephridia; this opens into the buccal cavity by a long duct. The intestine has no cæca or glands.

The above descriptions contain the main specific characters of these species. I shall now proceed to review their external and structural characters in greater detail, comparing them with each other, with other species of the genus, and with other genera.

Part II.

§ *Integument.*

Under this head will be discussed the external characters of the genus *Acanthodrilus*, as well as the structure of the integument.

Clitellum.—In the specific definition it has been already stated that the clitellum occupies in all the three species under consideration eight segments, from the 12th to the 19th inclusive. In other species the extent of this modified region of the integument appears to be different. In *A. ungulatus* it only occupies four segments, from the 14th to the 17th; *A. büttikoferi*, on the other hand, has a clitellum which is only one segment short of *A. multiporus* &c., reaching as it does from the 13th to the 19th segment.

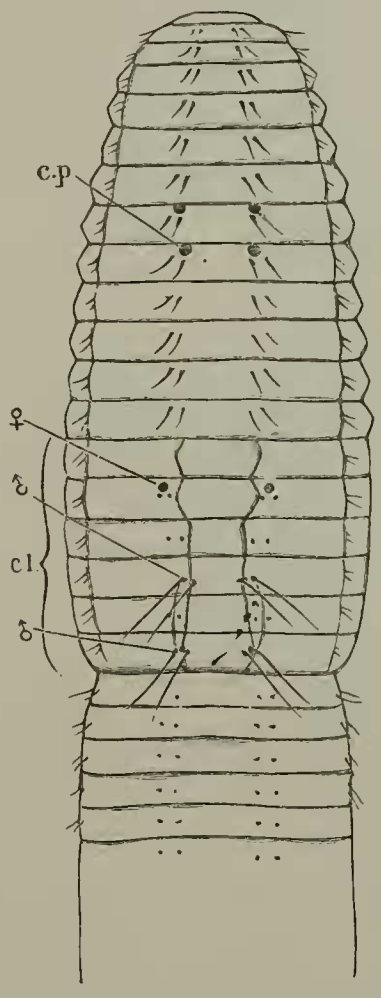
M. Perrier, as is well known, has divided Earthworms into three great groups, characterized by the different relations borne by the male generative apertures to the clitellum: in the Preclitellians the male generative pores are placed in front of the clitellum, in the Intraclitellians within it, and in the Postclitellians behind it. Now, in all the three species of *Acanthodrilus* described in the present paper, as well as in one species (*A. schlegelii*) described by Dr. Horst, the male generative apertures are placed *within* the clitellum; M. Perrier's location of the genus *Acanthodrilus* within the group of Postclitellians depends upon the examination of a single species referred to above, viz. *A. ungulatus*. As M. Perrier's classification in this instance at least separates species so closely allied as *A. ungulatus* and *A. schlegelii*, or any of the species defined in the present paper, it is evidently based upon characters which are not of final importance.

We are at present acquainted with so very few Earthworms, comparatively speaking, that the time has hardly arrived for a systematic arrangement of the whole group. It seems to me, however, that if any primary division is possible at all, it should be between the Preclitellian group on the one hand and the Intra- and Postclitellian on the other. The two latter have a good many characters in common which are not shared by *Lumbricus*; as instances may be mentioned the general presence of prostates, the position of the gizzard, strung on to the œsophagus, instead of being placed at its posterior extremity, the position of the testes and spermathecæ in

different segments, the communication of the transverse hearts with the supra-intestinal vessel, &c.

The clitellum in *Acanthodrilus*, as in many other Earthworms, is saddle-shaped; the only other form of clitellum met with is in

Fig. 1.



Acanthodrilus novæ zelandiæ.—Anterior region of body from ventral surface.

cl. clitellum, ♂, male generative apertures; *c.p.* apertures of copulatory pouches; ♀, female generative aperture, with long penial setæ. Inside of the generative apertures is a line which marks the boundary of glandular region of clitellum; this is not continued on to 12th and 19th segments, which are only partially occupied by the extension of the clitellum.

such forms as *Perichæta*, where the clitellum completely encircles the whole body. The peculiar form of the clitellum appears, however, in this genus to bear some relation to the development of the male generative orifices; it ceases to exist where these structures are

placed; in *A. ungulatus*, where the generative organs are placed behind the clitellum, the latter is developed all round the body as in *Perichæta*.

Setæ.—In *A. novæ zelandiæ* and *A. dissimilis* the setæ are disposed in four series of pairs, which is the typical arrangement of this genus; in *A. multiporus*, as well as in Lankester's *A. kerguelenensis*, the two setæ of each pair become widely separated from each other, so that there are eight longitudinal and nearly equidistant rows of a single seta each. An intermediate condition is offered by *A. schlegelii* and *A. capensis*, where the setæ are at first paired but subsequently come to lie further apart.

I have not been able to detect any characteristic differences in the shape of the setæ in the three species. In *A. multiporus*, and apparently in this species only, the setæ are furnished with a pair of remarkable glands which do not seem to have been described in any other Earthworm. I have figured these in a paper upon the nephridia of this species, which will shortly be published in the 'Annales des Sciences Naturelles.' These glands are more or less pear-shaped, and terminate in a duct which approaches and possibly pours its secretion into the seta-sac; the relations of these glands to the seta reminded one very forcibly of the sebaceous glands of the hair-follicle to the hair. A considerable space is left in the longitudinal muscle-coat round each seta, which is partly occupied by a delicate network of connective tissue, and is traversed by the special muscles which serve to move the seta. In this network the glands referred to lie one rather in front of, and one rather behind the seta; they are composed of rounded cells each with a very distinct nucleus; they are not concerned, or at least they are not directly concerned, in the production of new setæ. The young setæ appear first in the substance of large peculiar cells placed below the setæ, as has been described by Perrier and Vejdovsky, which have no relation whatever to these glands; it is possible that they produce some poisonous secretion, which secures to the worm protection from its foes; they may correspond.

The structure of the integument presents no special peculiarities: the epidermis consists of the ordinary columnar cells, among which are dispersed larger oval glandular cells; these latter are absent round the various apertures (setæ, nephridia, copulatory pouches, &c.) which pierce the integument. Between the epidermis-cells at their bases is a quantity of granular matter which has the appearance of pigment. The ultimate ramifications of the vascular system do not penetrate within the epidermic layer, except in the region of the clitellum; and I mention this fact because in certain Earthworms the epidermis is vascular. In *Megascolex*[1] and in *Perionyx*[2] at any rate there are intra-epithelial capillaries. The study of species of *Perionyx* from Manilla, which I owe to the kindness of my friend Mr. H. E. Barwell, and which may or may not be identical with the species referred to above, enables me to confirm this statement.

[1] Trans. Roy. Soc. Edin. vol. xxx. pt. 2.
[2] Proc. Roy. Phys. Soc. 1883–84, p. 89.

§ *Alimentary Canal.*

The alimentary tract of *Acanthodrilus*, as of other Earthworms, consists of a straight tube passing from the ventrally placed mouth at the anterior extremity to the terminal anus; it is specialized into several distinct regions.

The buccal cavity passes almost immediately into a large wide pharynx, which is attached to the body-wall by a mass of muscular bundles of various thickness; in the pharyngeal region the mesenteries, which posteriorly limit the segments, are no longer recognizable, but have become metamorphosed into this mass of muscles.

In *A. dissimilis*, and probably also in *A. novæ zelandiæ*, a quantity of glandular tissue lies on the dorsal surface of the pharynx between the muscular fibres, which, no doubt, represents a salivary gland such as that which Perrier has described in *Pontodrilus*. I have been unable, however, to make out the ducts of these glands.

In *A. multiporus* there are also salivary glands, which I am inclined to think are morphologically different from those of *A. dissimilis*. At the sides of the pharynx in segment 4 (Plate LIII. fig. 4, *gl*) are a pair of large arborescent glandular masses; the tubules which compose the gland of either side unite to form a slender duct (*d*), which is accompanied by a blood-vessel giving off capillaries which ramify over its walls. I traced the duct as far forward as the circumœsophageal commissure; at this point it passed under the commissure to open out the buccal cavity by a very conspicuous orifice (see fig. 5, *o*). The three anterior segments of the body occupied by this pair of glands and their ducts have no nephridia; and as the structure of these glands resembles exactly that of the nephridia, there is little doubt that they are the slightly modified representatives of the nephridia of these segments; the most anterior nephridia were in the fourth segment, *i. e.* the third in front of that which contains the most anterior pair of copulatory pouches. Each gland consists of a multitude of cæcal (?) tubes accompanied by an abundant supply of capillaries. Distally, the gland-tubules consist of rows of perforated cell quite similar to those of the distal section of the nephridia in *Lumbricus* &c.; this portion of the tubule forms a complicated coil. Where the tubules unite together the character of the epithelium changes, and the duct comes to be surrounded by a row of cells instead of being contained within the substance of the cell. As the glands open into the buccal cavity, they may be termed salivary glands; they appear to correspond to the "glande à mucosité" described by Perrier in the genus *Urochæta*[1]: there are two of these glands situated in the anterior region of the body, each opening by its own duct *on to the exterior* in the third segment. Like the salivary glands of *Acanthodrilus*, the mucous glands of *Urochæta* have precisely the same structure as the nephridia; and the fact that the latter are wanting in those segments of the body which contain the glands and their ducts is an additional argument for supposing, as

[1] Arch. de Zool. Exp. t. iii. p. 439, pl. xvi. figs. 35, 37, 43.

Perrier suggests, that they are the homologues of the nephridia belonging to these segments. Similar glands are stated by Perrier to occur in *Perichæta*, but in this genus it was not possible to observe the external aperture of the glands. Seeing that the buccal cavity is morphologically external, it is not surprising to find that the same glands may in some cases open directly on to the exterior, and in other cases indirectly by means of the buccal cavity. Similar glands are also found in many of the Limicola; Vejdovsky in his 'Monographie der Enchytræiden'[1] records their presence in several species of *Enchytræus*, *Anachæta*, and other genera, comparing them with the "glandes à mucosité" of *Urochæta*.

Following upon the pharynx is the narrow œsophagus, which presently widens out in the eighth and ninth segments to form the gizzard, an organ that is found in all Earthworms except in *Pontodrilus*. The structure of the gizzard is in no way remarkable: it is surrounded by a very thick circular muscular coat, outside which is a delicate layer of longitudinal fibres; a few radiating muscles pass through the circular layer; it is lined by a tall columnar epithelium which secretes a very thick cuticle. The position of the gizzard, placed as it is along the course of the œsophagus, is the same that has been found to occur in all Intra- and Postclitellian Earthworms; in *Lumbricus* alone the gizzard marks the posterior termination of the œsophagus.

Behind the gizzard the œsophagus is rather wider than it is in front, and becomes extremely vascular; even in the spirit-preserved specimens which I have dissected, this region of the œsophagus is conspicuous from the abundant presence of blood-vessels, which form two systems:—(1) a superficial plexus, (2) an internal blood-lacuna which surrounds the gut, lying just within the lining epithelium.

In relation to the œsophagus are developed certain peculiar glands, which appear to correspond to the "calciferous glands" of *Lumbricus*.

In the common Earthworm (*Lumbricus*) the hinder region of the œsophagus is furnished with three pairs of lateral diverticula, which have been long known as the calciferous glands, or glands of Morren; of these the anterior pair are the larger. The structure of these glands has been described by Claparède[2]; in the region where they are found the œsophagus is extremely vascular, and consists of a number of radiately arranged glands or follicles divided by septa of connective tissue enclosing a blood-space. The calciferous gland itself is merely a diverticulum of the œsophagus, and is made up of exactly the same structures, only the follicles are deeper. Claparède states that he has never observed the formation of the calcareous particles secreted by these glands within the gland-substance.

In the genus *Urochæta*, Perrier[3] has described three pairs of similar glands, which are of very much larger size than in *Lumbricus*, but appear to present a more or less similar structure.

[1] *Loc. cit.* p. 29.
[2] Zeitschr. f. wiss. Zool. Bd. xix. 1869, p. 602.
[3] Arch. d. Zool. Exp. t. iv.

There are certain glandular structures present in all three species of *Acanthodrilus*, which appear to represent these three calciferous glands of *Lumbricus* and *Urochæta*.

In *A. novæ zelandiæ* and in *A. dissimilis*, in the thirteenth segment the œsophagus undergoes a remarkable alteration in its character; it apparently widens considerably (Pl. LII. fig. 2, *gl*), and this saccular dilatation, when cut open, presents an appearance somewhat like that of a ruminant's stomach; a number of leaf-like folds project into the lumen of the tube. In the following segment the œsophagus is again somewhat dilated (fig. 2, *gl'*) before it returns to its original calibre; a series of transverse sections (Pl. LII. fig. 1) shows that these supposed dilatations to the œsophagus are distinct glands, which are separated from its walls anteriorly and posteriorly; in the middle their lumen is directly continuous with the lumen of the œsophagus without the intervention of a duct. The glands of either side are quite separate from each other; on the dorsal side of the œsophagus the two glands of each pair nearly come into contact, being separated only by a very narrow space, in which the dorsal vessel and the short mesentery connecting it with the gut lie. Ventrally the glands of each pair are widely separate.

The posterior pair of glands differ from the anterior in being trilobate. Each is divided by horizontal furrows, coinciding with the long axis of the body, into three separate lobes. The anterior pair of glands are unilobate, and considerably smaller than the posterior pair; otherwise their structure is the same. The accompanying drawing (Pl. LII. fig. 1) will give a correct notion of the appearance of the posterior pair of glands under a low power.

In *Acanthodrilus multiporus* there are apparently only a single pair of calciferous glands present (Pl. LII. fig. 3, *gl*), the specialization of which has gone a step further; instead of being little more than mere dilatations of the œsophagus, the calciferous glands of this species are quite separate from the œsophagus, communicating with it only by a short narrow duct. The structure of these glands appears to be identical in all three species.

They consist of numerous lamellæ concentrically arranged, reaching from the walls of the gland to its opening into the œsophagus; these lamellæ are, however, of different lengths, as will be apparent from the drawing (Plate LII. fig 1). In *Lumbricus* Claparède figures the lamellæ of equal lengths. The lamellæ consist of a core of connective tissue, in which is a large blood-lacuna, and on either side a row of cells which secrete the calcareous corpuscles, and with which they are filled, as also is the lumen of the gland. Claparède did not succeed in observing the calcareous corpuscles in course of formation, although he found the lumen of the gland and the œsophagus full of them.

The structure of the calciferous glands of *Urochæta*, judging from M. Perrier's description and figures, appears to be different; instead of a series of lamellæ, there appear to be a quantity of closely-packed cæcal tubes.

The folded structure of the calciferous glands of *Acanthodrilus*

is simply an exaggeration of the structure of the œsophagus, which is traversed by numerous longitudinal folds.

The œsophagus passes gradually into the *intestine*, which is distinguished by its greater calibre, and extends to the anus without any variation in its character. The intestinal epithelium is ciliated, and the ciliation is continued forwards into the œsophagus as far as the calciferous glands; in front of the calciferous glands the œsophagus does not appear to be ciliated.

The intestine is unprovided with cæca or with glands of any description.

The *typhlosole* has a characteristic form, and serves to distinguish *A. multiporus* on the one hand from *A. novæ zelandiæ*, and *A. dissimilis* on the other. In the two latter species the typhlosole, on a superficial inspection of the intestine, appeared to be absent; in transverse sections it may be seen to be present, though extremely rudimentary. On the upper side of the intestine, just below the dorsal blood-vessel, the muscular coat is prolonged downwards for a short distance into the lumen of the gut, and the lining epithelium covers the projection, which only measures $\frac{1}{10}$ of the lumen of the intestine; in certain regions the typhlosole was a little more complicated, being bifurcate at its extremity, indicating an approach to the structure of the typhlosole of *A. multiporus*.

In this species, on the dorsal side of the intestine, and projecting into its lumen, is a very conspicuous typhlosole. The typhlosole is well developed throughout the greater part of the intestine, but gradually decreases, and finally disappears in the hindermost region of the gut. In the largest example of this species, measuring about 11 inches in length, the region of the intestine devoid of typhlosole was rather more than one inch in length. The typhlosole projects into the lumen of the intestine in the middle of the body, where it is well developed, for a space of about half of its diameter; more exact measurements show that the extreme length of the typhlosole is to the circumference of the intestine as 6 : 30. In transverse sections it may be seen that the typhlosole is not a single fold; it consists in fact of three folds, two lateral and one median, which unite together to form a single fold attached to the wall of the gut. The lateral folds are subequal, and considerably deeper than the median fold; their vertical diameter is from two to three times that of the median fold. The typhlosole arises from the dorsal wall of the gut at a point exactly between the two dorsal vessels. Its structure is exhibited in Plate LIII. fig. 1. It is an outgrowth of the epithelial wall of the intestine, surrounding a blood-sinus. The cells are tall and columnar, and resemble in every particular the lining epithelium of the intestine. Between the cells which form the opposite walls of each of the three folds is a continuous blood-sinus, which widens out at the cæcal extremity of both the median and the lateral folds, and also above the point of junction of the three folds, where it forms a wide reservoir, cup-shaped in transverse section. I did not succeed in tracing the blood-sinuses of the typhlosole into connection with any similar blood-

sinus in the walls of the intestine itself; but I have little doubt, from the analogy of *Acanthodrilus novæ zelandiæ*, that such a sinus exists. A delicate layer of transverse muscles, continued into the typhlosole from the intestinal walls, enclosed the blood-plexus.

§ *Vascular System.*

Concerning the vascular system of *Acanthodrilus* I have but few remarks to offer; to study the circulation thoroughly it is requisite to have living specimens.

In a short paper in the 'Proceedings of the Royal Physical Society'[1] I have referred to the double condition of the dorsal vessel in two of these species, so that I need do no more than briefly recapitulate the main points of that paper, which are as follows:—In the genera *Megascolex* and *Microchæta* the anterior section of the dorsal vessel is formed of two separate tubes, which become united at the points where they traverse the mesenteries. In *Acanthodrilus novæ zelandiæ* the separation of the dorsal vessels into two distinct tubes has gone a step further (Pl. LIII. fig. 6): the whole of the vessel except the anterior extremity lying upon the pharynx is divided into two separate tubes which only unite at each mesentery. In *A. dissimilis*, which agrees so closely in external as well as in anatomical characters with *A. novæ zelandiæ*, the dorsal vessel is a single tube, and appears to be always so. It is not possible, however, to use this retention of an embryonic character in *A. novæ zelandiæ*, which is analogous to the partial retention of the left aortic arch in the Raptores among birds, to distinguish the species absolutely from *A. dissimilis*, for in one example of the former species the dorsal vessel was single.

In *A. multiporus* the primitive double condition of the dorsal vessel is more complete still. In this species the dorsal vessel is composed of two tubes which run from end to end of the body and are not fused at the mesenteries.

The dorsal vessel is connected with the ventral (supra-nervian) by a number of transverse trunks, the last pair of which are situated in the thirteenth segment. The last four pairs arise both from the dorsal and supra-intestinal trunks, as Perrier has recorded in *Pontodrilus* and other genera.

The supra-intestinal trunk lies on the surface of the alimentary canal, and is concerned with the supply of the intestinal blood-plexus. In one specimen of *A. novæ zelandiæ* this vessel was double; beneath the œsophagus is another longitudinal blood-vessel, which I did not observe in the intestinal region.

The supra-nervian trunk is connected with the median ventral line of the intestine by a mesentery; and in the œsophageal region the dorsal vessel, which here lies some way above the alimentary tract, is connected with it, as elsewhere, by a similar mesentery, or two, one for each dorsal vessel where it is double.

In the thirteenth to about the nineteenth segment is a lateral vessel on either side; it appears to arise from a transverse heart.

[1] 1884–85, p. 424.

§ *Nephridia.*

Hardly anything is known about the nephridia in the genus *Acanthodrilus*. Perrier does not refer to their presence in his description either of the genus [1] or of the three species examined by him. A statement that the apertures of these glands are placed above the ventral pair of setæ [2] implies, however, their existence. Dr. Horst [3] failed to find any nephridia at all in *A. schlegelii*; and in *A. büttikoferii* they appear to be represented solely by a tufted organ in the anterior part of the body, attached to the pharynx, which is probably identical with the "salivary" gland of *A. multiporus*, to which I have already referred. They are present in *A. kerguelenensis* and in *A. capensis*.

In all the three species described in the present communication nephridia are found; in *A. multiporus* I have already [4] described the structure and distribution of the nephridia. This species is apparently unique among Earthworms in possessing a single nephridium to each of the eight setæ, the duct of which opens in close proximity to the seta by a single orifice in the posterior part of the body; in the anterior part of the body the duct of each nephridium branches and opens by a multitude of orifices.

A. novæ zelandiæ and *A. dissimilis*, the nephridia are remarkable in that they alternate in position from segment to segment of the body. It is a general rule among Earthworms, possessing only a single pair of nephridia in each segment of the body, that the position of the external apertures of these is constant. In *Lumbricus* the nephridia are related to the ventral pair of setæ, near to which they open, and the same is the case with *Eudrilus* and several other genera. Perrier discovered that in other genera (e. g. *Rhinodrilus*) the nephridia bore a similar relation to the dorsal pair of setæ or to one of these setæ, if the two had become separated, as is so often the case. These facts led M. Perrier to support Prof. Lankester's hypothesis of the typical presence of two series of nephridia in Earthworms corresponding to the two series of pairs of setæ.

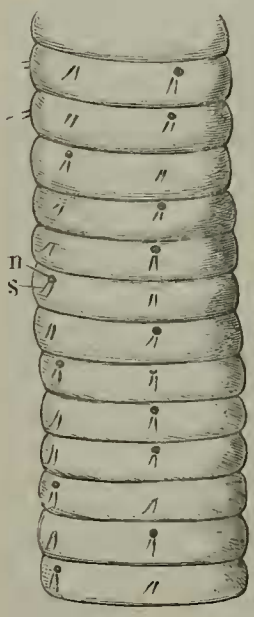
The characters of the genus *Plutellus* appeared to be entirely confirmatory of this hypothesis. In this Earthworm the setæ are disposed in eight longitudinal rows of a single seta each, and the external orifices of the nephridia alternate in position from segment to segment, sometimes being situated near to one of the two dorsal setæ, sometimes near to one of the ventral setæ. I have elsewhere pointed out that these facts really indicate the partial persistence of four series of nephridia [5] corresponding to the four rows of setæ, and entered to some extent into the questions raised by Prof. Lankester's hypothesis, so that I need not recall the matter.

In *A. novæ zelandiæ* and *dissimilis*, where, as has already been

[1] Nouv. Arch. &c. p. 85.
[2] *Loc. cit.* p. 162.
[3] Notes from Leyden Museum, vol. vi. pp. 105, 107.
[4] Proc. Roy. Soc. no. 238, 1885, p. 459. See also a forthcoming paper in Ann. Sci. Nat.
[5] Proc. Roy. Soc. *loc. cit.*

mentioned, the setæ are in four series of pairs, the nephridia similarly alternate in position from segment to segment (woodcut, fig. 2). There does not, however, appear to be any regularity in this alternation: sometimes the nephridia of five or six consecutive segments open by the same series of setæ on both sides of the body. In other segments there is an asymmetry of the nephridia of the two sides of the body: for example, the left-hand gland may open by the dorsal, while the right-hand gland opens by the ventral pair of setæ; occasionally

Fig. 2.



Acanthodrilus novæ zelandiæ.—A portion of the body viewed from the side. *n*, nephridial pores; *s*, setæ of ventral pair.

there is a regular alternation coupled with absolute symmetry in the position of the nephridial pores. Moreover, no two individuals of either species that I examined were exactly alike in these respects; and it was impossible to distinguish one species from the other by the position of the nephridial pores; occasionally the nephridia, one or both, were found to coincide at the same series of setæ as the male and female genital ducts, but in no case did I observe a similar coincidence of nephridium and spermatheca.

Another point of interest in connection with the nephridia of these two species has not been recorded by Perrier in *Plutellus*: the two series of nephridia, dorsal and ventral, show other indications besides the varying position of their apertures of being the vestiges of two complete series; in every instance *it was found possible to distinguish the nephridia of each series by morphological differences.* In all the nephridia the muscular portion which forms the distal extremity of

the gland, and which may be regarded as its duct, is hypertrophied compared to what it is in *Lumbricus*. In the dorsal series of nephridia this muscular duct is extremely long, and before perforating the body-wall it gives off a minute cæcum which extends beyond (dorsal to) the external orifice; in the most anterior segments of the body this diverticulum is not present (Plate LII. fig. 4). In the ventral series of nephridia the terminal muscular duct is very short, but it is connected with, and opens into, a large sac-like diverticulum (Plate LII. fig. 5) about equal in length to the muscular duct of the dorsal nephridia, and which lies, not beyond the setæ, but on the same side of them as the nephridium itself.

The differences above indicated are absolutely distinctive of the two series of nephridia: wherever these organs opened by the ventral pair of setæ they were found to have a large diverticulum developed at the expense of the terminal duct, which is in consequence short; wherever they opened by the dorsal pair of setæ, the muscular duct was long, the cæcum short, projecting on to the further side of the setæ.

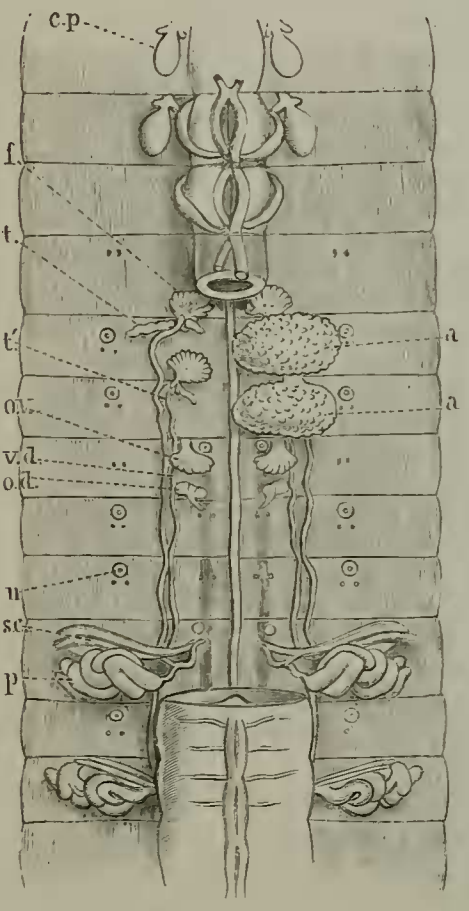
§ *Generative Apparatus.*

The *male generative apparatus* of *A. novæ zelandiæ* as well as the other two species consists of two pairs of testes, two pairs of vasa deferentia, with which are connected a prostatic gland and a number of peculiarly modified setæ. The position of the several glands and their ducts are shown in the accompanying drawing (fig. 3, p. 825).

The *testes* are situated in segments 11 and 12, and have the form of racemose glands composed of a number of spherical acini. When the body is opened the testes are seen to extend above the dorsal vessel but are not united together; the testis of each side is free from its fellow; they are attached by a stalk to the anterior mesentery of the segment which they occupy; in the tenth and eleventh segments are the funnels of the vasa deferentia; the pair of funnels of each segment are close together on either side of the median line and just above the nerve-cord; the margins of the funnel are extremely folded and complicated, which renders their detection a matter of great ease; it is rather curious to find that the anterior pair of funnels are situated in the segment in front of that which contains the anterior pair of testes, but a similar condition has been recorded in other Earthworms. It must be noted that the funnels of the vasa deferentia are entirely independent of the testes; they project freely into the interior of their respective segments, and there is no possibility of regarding the testes as an expanded portion of the true funnel of the vasa deferentia. The testes therefore in this Earthworm are the real sexual glands and are not the homologues of the so-called "testes" of *Lumbricus*, which are merely the dilated ends of the vas-deferens funnels. As is well known, the real testes of the common Earthworm are four minute bodies, which discharge their contents into the sac-like termination of the vasa deferentia, and seem to disappear when the animal is mature; it is

these bodies that are homologous with what I have described as the testes of *Acanthodrilus*. The structure of the male generative organs in *Lumbricus* appear therefore to be exceptional, since it is almost the general rule among Earthworms for the testes to be large

Fig. 3.



Acanthodrilus dissimilis.—Dissection of genital region.

c.p, Copulatory pouch; *a*, testes; *f*, funnels of vasa deferentia; *v.d*, vas deferens; *ov*, ovary; *o.d*, oviduct; *n*, opening of nephridia; *t*, *t'*, peculiar glands homologous (?) with ovaries; *p*, prostate; *sc*, sac containing penial setæ. A portion of the œsophagus, and the testes of left side have been removed.

glands, not in the least comparable in size to the ovaries. The fact that the true testes of *Lumbricus* are approximately of the same size as the ovaries, might lead any one to doubt on *à priori* grounds of the correctness of my description; but the racemose character of the testes in *Acanthodrilus*, which I have found more marked in

Megascolex, and which undoubtedly occurs in other Earthworms, coupled with their absolute independence of the vas-deferens funnels, is, I think, sufficient to show that my determination is correct.

The vasa deferentia, instead of uniting to form a single tube, as appears to be the case in the majority of Earthworms, remain obviously distinct from each other for the whole of their course; they pass down close to the ventral pair of setæ, but to the outside of them, and in certain regions, at any rate, are not very firmly fixed to the body-wall; their walls are supplied with abundant blood-capillaries. On referring to Perrier's description of the anatomy of *Acanthodrilus*, I find that he figures the vasa deferentia in *A. ungulatus*[1] as being composed of two widely separated tubes.

The *prostate glands* are two pairs, each connected with one of the four male genital apertures; each consists of a thick-walled glandular tube variously coiled upon itself, and terminating in a narrow muscular duct which has a nacreous glitter. In *A. multiporus* (Pl. LIII. fig. 2) the mesenteries in the neighbourhood of the prostates are arranged in a somewhat radiating fashion as bands of nacreous-looking fibres, which are attached at one extremity to the ventral body-wall, close to the apertures of the prostate; they perhaps serve as special "cremaster" muscles. With each of the male generative apertures is connected a thin-walled muscular sac containing a number of long penial setæ, hooked at their extremity, but not ornamented in the way that is often found in *Acanthodrilus*. There is therefore nothing remarkable in the male generative system of this species, except in the fact that the apertures are situated within the clitellum instead of behind it; it is, with the exception of this relation of its aperture to the clitellum, precisely similar to the male generative system of other *Acanthodrili*, even to the numbers of the segments on which the vasa deferentia open. If systematists are unwilling to include this species within the genus *Acanthodrilus*, it cannot, at any rate, be placed far from it, certainly not in a distinct group.

In describing the external characters of these worms, it should have been mentioned that the male apertures are situated upon the summits of conspicuous papillæ; transverse sections through this region of the body-wall show that the papillæ are the result of the more elongated form of the epidermic cell surrounding the apertures of the generative ducts; the cells which cover the papillæ are from three to four times the length of the cells that are found elsewhere, but are similar to them in their structural characters. In *A. dissimilis* the duct of the prostate gland comes into close relation with the genital setæ; the latter are of course homologous with the ordinary locomotor setæ, and simply replace them upon the genital segments.

Each of the two genital setæ corresponding to each genital aperture is contained in a separate sac, which is lined by a continuation of the epidermis, and communicates with the exterior by a separate orifice. There are of course numerous accessory setæ, which

[1] *Loc. cit.* pl. ii. fig. 18.

are equivalent to the "soies de remplacement" of the locomotor setæ; these, however, are contained within the body-cavity and do not protrude on to the exterior. It is important to notice that the genital setæ, although different in appearance from the ordinary locomotor setæ, do not differ in their disposition; and, moreover, the aperture of the conjoined vas deferens and prostate duct has a relation to the setæ precisely similar to that which has already been referred to in the case of the nephridial aperture and the locomotor setæ (see p. 822). The apertures of the vasa deferentia, like those of the nephridia, correspond in position to the outermost setæ of the pair.

§ *Female Generative Organs.*

In *Acanthodrilus novæ zelandiæ* and *A. dissimilis* the ovaries are to be found in the 13th segment, *i. e.* next to that which contains the posterior pair of testes; they are attached to the anterior mesentery of this segment close to the middle line. The ovaries are of a very peculiar form; instead of being round, or, rather, pear-shaped as in *Lumbricus*, they present the appearance of a flattened circular disk, much folded and plicated; their resemblance indeed to a vas-deferens funnel is so striking, that I mistook them at first for such a structure, until a microscopical examination revealed their true nature. I find a figure by M. Perrier of the ovary of *Perichæta houlleti*[1], which shows a great resemblance to the ovaries of this *Acanthodrilus*. It is interesting to note the different positions which the ovaries may occupy in Earthworms: in *Lumbricus* they are situated on the anterior wall of the segment in which they are found, and, as in *Acanthodrilus*, this is the 13th segment of the body; in *Perichæta* and *Microchæta* the ovaries are found in the same segment of the body, but upon the posterior mesentery; in *Acanthodrilus multiporus* I have to record the position of the ovaries in the same segment, but attached to the anterior margin of the oviduct-funnel and apparently to the ventral body-wall, between the two mesenteries which enclose the segment.

In *Acanthodrilus dissimilis*, also in *A. novæ zelandiæ*, the oviducts open separately in front of the ventral pair of setæ of each side; a series of transverse sections through this region show that the apertures bear a particular relation to the outermost of these two setæ. There is nothing remarkable in the structure of the oviducts. The oviducts of *A. multiporus* open by the innermost of the two ventral setæ, so that the position is slightly different. In all three species there are a series of peculiar glands, two pairs situated in the 11th and 12th segments. The position of these structures in *A. dissimilis* and *A. novæ zelandiæ* is shown in the drawing (wood-cut, fig. 3) which illustrates the generative region of *A. dissimilis*. The general appearance of these glands is not unlike that of the ovaries; they are somewhat rosette-shaped, being formed of a much plicated disk, attached by a narrow pedicle to the anterior mesentery, and depending freely into the interior of the segment; the general

[1] Nouv. Arch. &c. *loc. cit.* pl. iii. fig. 60.

shape of these glands may be understood from the same drawing. From transverse sections through the body, it could be seen that these glands are closely adjacent to the terminal portion of the vasa deferentia (Plate LII. fig. 9) just before they perforate the mesentery.

These glands possibly correspond to a pair of somewhat similar glands described and figured by Perrier in *Pontodrilus*[1]; they are also possibly to be compared to two glandular masses which I have described myself in *Megascolex*[1].

The position of these glands exactly corresponds to that of the ovaries, attached as they are to the anterior mesentery of their segment close to the middle ventral line; their structure exactly resembles that of the ovaries in those regions where the fully formed ova are not found. A more positive proof that these glands are the morphological equivalents of ovaria is the fact that in one example of *A. dissimilis*, that I have studied, by means of transverse sections, *the posterior right-hand gland contained abundant ova, which resembled in every detail the ova produced by the true ovaries* which lie in the succeeding segment. Beyond this single fact, which may be an abnormality, but, like other abnormalities, serves as clue to a morphological comparison, I have no evidence to offer as to the function of these structures.

The fact that there are frequently more than a single pair of testes in Earthworms—there are two pairs for example in the present species—renders it more probable still that the comparison which I have instituted is a correct one. The multiplication of ovaries, as well as of testes, naturally recalls the condition met with in hermaphrodite Polychæta. These species of *Acanthodrilus* appear, in fact, to have preserved more completely than any other Earthworms, the anatomy of which is known, the primitive condition of the generative organs.

There is no Oligochætous Annelid in which more than a single pair of ovaries are known with certainty to occur; *Euclipidrilus*, according to Eisen[2], possesses three pairs of ovaries; and in *Chætogaster limnæi*, Lankester[3] has described two pairs which are not mature at the same time. Vejdovsky[4], however, states that he has never succeeded in finding the second pair in *Ch. limnæi*, and is of opinion that Eisen has mistaken other organs for the additional pairs of ovaries in *Euclipidrilus*.

The above suggestion as to the homologies of these anterior glands is also borne out by their relations in the third of the three species, viz. *A. multiporus*. It has already been mentioned that the ovaries of this *Acanthodrilus*, instead of being attached to the anterior wall of the 13th segment, are attached to its posterior wall in close connection with the oviduct. There is a similar change in position of the glandular bodies, which come to lie beneath the funnels of the

[1] *Loc. cit.* pl. xiv. fig. 9, pl. xvii. fig. 37, and *loc. cit.* p. 504.
[2] Roy. Soc. of Sciences, Upsala, 1881.
[3] Quart. Journ. Micr. Sci. vol. ix. new ser. 1869.
[4] System und Morphologie der Oligochaeten. Prag, 1884, p. 145.

vasa deferentia, and are consequently not obvious on a dissection of the worm, since they are largely concealed by the funnels and are only evident on raising the latter. In transverse sections (Plate LII. fig. 9) they are very conspicuous, and although attached by a pedicle to the sides of the funnel, their tissue is unmistakably different from the elongated ciliated cells which compose the latter, and is absolutely similar to that of the homologous glands in the other species; the change in the position of the glands naturally moves them a segment further forward than in *A. dissimilis*, and there is consequently a segment lying between the ovaries and the posterior pair of glands.

Copulatory Pouches.—Copulatory pouches (spermathecæ) are present in all three species, and have a characteristic form which serves to discriminate the species. In all there are two pairs which are situated in the 7th and 8th segments, and open on to the exterior in the furrow which separates each of the segments from the preceding one, in front of the ventral pair of setæ; in *A. multiporus* the apertures of the copulatory pouches are related to the outermost of the two ventral setæ. The copulatory pouches are large oval sacs, communicating with the exterior by a short, thick-walled duct. In *A. multiporus* the pouches appeared to be without diverticula; in *A. dissimilis* each of the copulatory pouches (Plate LIII. fig. 9) is furnished with a pair of long diverticula opening into the duct of the pouch, one on either side. The disposition of the diverticula varied in different specimens: in one specimen the diverticula were contained in the same segment as the pouch, with the exception of one of the two diverticula of the posterior left-hand pouch, which passed through the mesentery and projected into the 8th segment: in another example both diverticula of the two anterior and one of the posterior pouches, in the segments anterior to those in which the pouches themselves were situated. In *A. novæ zelandiæ* the terminal portion of the duct of the copulatory pouch is beset with a great number of small diverticula arranged in the form of a rosette (Plate LIII. figs. 3 and 8); as in *A. dissimilis*, the diverticula sometimes seem to lie in the same segment as the copulatory pouch itself, sometimes in the segment in front.

In *Acanthodrilus dissimilis* the structure of the copulatory pouches and of their diverticula undergo certain changes during the life of the animal, which are evidently connected with the process of fecundation.

In individuals, which I take to be not completely mature, the copulatory pouch has the structure illustrated in Plate LII. fig. 8; within the muscular layers, which are thin and abundantly vascular, is a layer of tall, columnar, nucleated cells; on a superficial view these cells present the appearance indicated in fig. 7 of the same Plate; they are extremely narrow and somewhat hexagonal in contour; the epithelial lining of the copulatory pouch is thrown into folds which are often very regular in their arrangement (Plate LIII. fig. 7), but only consist of a single layer of cells.

In another individual the structure of the epithelium of the copulatory pouch is somewhat more complicated: a small portion

of this epithelium is displayed in Plate LII. fig. 6. The columnar cells are still present and of the same general appearance, but between them are a number of large, oval, granular cells (*a*), which are considerably shorter and do not reach the surface; towards the external aperture of the pouch the granular cells disappear, and the epithelium gradually passes into the outer epidermis without any distinct break.

These changes in the structure of the copulatory pouch are accompanied by changes in the structure of its diverticula. Before describing these, I should mention that the copulatory pouches were invariably empty of spermatozoa; in no case did I find the least traces of spermatozoa in the copulatory pouch itself; on the other hand, the diverticula were as invariably *full* of spermatozoa compacted together in a way that will now be described.

In the first-mentioned individual, in which the copulatory pouches present the more simple structure, the accessory pouches are also comparatively simple in their structure. The epithelium consists of tall columnar nucleated cells, quite similar to those which form the inner lining of the copulatory pouch; the epithelial layer is thrown into folds, and in the distal portion of the chamber these folds meet and divide the cavity into a number of smaller cavities; of the copulatory pouch itself, on the other hand, the cavity is never thus subdivided. Here and there the epithelial cells are replaced by largish oval spaces, apparently filled with a fluid substance, and which are probably due to the degeneration of cells; in many of these were imbedded packets of spermatozoa arranged in longitudinal bundles and closely cemented together.

In the more mature individual the structure of the diverticula was almost completely lost: it appeared to form a completely solid mass, without any trace of a lumen or only just the faintest trace near to its external aperture. The interior of the pouch consists of masses of granular matter of various sizes and shapes (see Plate LIII. figs. 10 and 11), in which were imbedded bundles of spermatozoa; trabeculæ of a tissue, which may represent the degenerated epithelium, form a complete network, and separate off from each other the granular masses containing the spermatozoa.

This condition is obviously brought about by a still further activity of the epithelium of the diverticula, of which there were indications in the first stage.

It appears to me therefore that in this species the copulatory pouch itself has little or no share in the phenomena of reproduction; the spermatozoa, perhaps cemented together in bundles by the secretion of the prostate glands, are transferred direct to the diverticula of the copulatory pouches, where they undergo further change, which perhaps results in the formation of a spermatophore; I have not, however, succeeded in finding any spermatophores.

The main fact to which I wish to call attention, is that the *diverticula* of the copulatory pouch, and not the pouch itself, have the chief share in the process of fecundation.

In *A. novæ zelandiæ* I am not able to give any details of the

structure of the diverticula, which, as already mentioned, are extremely small, or to compare their structure with that of the main pouch; but I am able to state, as a fact, that the spermatozoa were contained within the diverticula and not in the pouch.

The foregoing considerations appear to me to indicate that the diverticula of the copulatory pouches are not merely "diverticula," serving to increase the storage room, but perform some definite function in relation to the spermatozoa, which function is not shared in by the copulatory pouch itself; the very general prevalence of diverticula to the copulatory pouch among Earthworms is an additional piece of evidence that these structures have some importance *per se*. In some species of *Perichæta* these supplementary pouches attain to an extraordinary degree of complication, and are quite divorced from the main copulatory pouch, opening on to the exterior by separate orifices. In *Microchæta* the copulatory pouch itself has apparently disappeared [1], and only the supplementary pouches remain. *Microchæta* is therefore at one end of the series, and *Lumbricus*, where there are no diverticula at all, at the other.

I have searched the literature of the subject in order to find out how far the statement that I have just made with regard to the copulatory pouches are in harmony with the observations of other writers. Perrier mentions that in *Urochæta* he never found spermatozoa in the copulatory pouches; but the observation is not of much value, as Perrier himself points out, since the examples of the worm were, without exception, in a condition of incomplete maturity. I can find no other positive statement except in Huxley's 'Anatomy of Invertebrated Animals,' where it is mentioned that the pouches are filled with spermatozoa when copulation takes place. It is possible that this does actually take place even in *Acanthodrilus dissimilis*, and that the spermatozoa are rapidly got rid of, and transferred to the diverticula, where they are compacted into masses. This is at any rate in accordance with the facts which I have been able to describe. Dr. Horst [2] mentions that in *Perichæta sumatrana* the diverticula of the copulatory pouches contained "an orange-coloured substance which, highly magnified, appeared to be a mass .....of spermatozoa."

In briefly running over the specific characters of the third species treated of in the present paper, viz. *A. multiporus*, I mentioned that the copulatory pouches appeared to be like those of *Lumbricus*, simple spherical sacs without diverticula. This statement requires some correction; on making a series of transverse sections through the copulatory pouch and the body-wall in its immediate neighbourhood, I detected a number of minute diverticula opening into the duct of the copulatory pouch just before its external aperture, and imbedded in the muscular layers of the body-wall. The diverticula, as in the other instances, contained abundant spermatozoa, which were entirely absent from the interior of the copulatory pouch itself; the latter contained a granular mass which appeared to be the

[1] Proc. Roy. Soc. no. 238, 1885, p. 462.

[2] Notes from Leyden Museum, vol. v. p. 190.

result of a coagulation by the hardening reagent of a fluid or semi-fluid substance; *in this were imbedded a vast number of spherical concretions*. The presence of these latter evidently suggests that the copulatory pouch itself may act as an excretory organ; and in view of the supposed homologies between the copulatory pouch and the nephridia, this fact is of some importance.

I carefully searched for concretions in the copulatory pouches of the other species, but did not succeed in finding any.

Vejdovsky, in his recently published 'System und Morphologie der Oligochæten,' has figured crystals and one concretionary body in the copulatory pouch of *Stylaria*[1], but I am unacquainted with any other facts comparable to those which have just been stated.

EXPLANATION OF PLATES.

Plate LII.

Fig. 1. Transverse section through œsophageal region of *Acanthodrilus dissimilis*. *œs*, Œsophagus; *gl*, calciferous glands; *d.v*, dorsal vessel; *v.v*, ventral vessel; *n*, nerve-cord.
2. Œsophagus and calciferous glands (*gl*, *gl'*) of *A. dissimilis*.
3. Œsophagus and calciferous glands (*gl*) of *A. multiporus*.
4. Dorsal nephridium of *A. novæ zelandiæ*.
5. Ventral nephridium of *A. novæ zelandiæ*.
6. Epithelium of copulatory pouch of *A. dissimilis*. *a*, Glandular cells.
7. Superficial view of same epithelium.
8. Epithelium of copulatory pouch of immature individual of same species.
9. Glandular body (*gl*) attached to vas deferens (*v.d.*) of *A. dissimilis*.

Plate LIII.

Fig. 1. Typhlosole (transverse section) of *A. multiporus*.
2. Prostates (*pr*) and modified mesenteries (*m*) of *A. multiporus*.
3. Copulatory pouches (*c.p*) and diverticula (*c.p'*) of *A. novæ zelandiæ*. *n*, nephridia.
4. Anterior end of body of *A. multiporus*. *c*, "Brain;" *d.v*, dorsal vessel; *n*, nerve-cord; *gl*, salivary gland; *d*, its duct; *ph*, pharynx.
5. Opening of ducts of salivary glands (*o*) within buccal cavity.
6. Portion of intestine, and paired dorsal vessel of *A. novæ zelandiæ*.
7. Transverse section of copulatory pouch of *A. dissimilis*.
8. Copulatory pouch of *A. novæ zelandiæ*.
9. Copulatory pouch of *A. dissimilis*.
10. Portion of diverticulum of copulatory pouch of *A. dissimilis* in transverse section, slightly magnified to show the bundles of spermatozoa (*gp*) imbedded in granular substance.
11. Transverse section of diverticulum of same species, less magnified. The bundles of spermatozoa which have taken up the staining fluid more than the surrounding tissue, are indicated as black masses.

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[1] Pl. iv. fig. 11.